Coulon, J. (1975): Les relations sociales chez le Cobaye domestique. II. Le comportement agonisti-que interterritorial. Behaviour 53, 200–215.

Fuchs, S. (1980): Spacing patterns in a colony a Guinea pigs: predictability from environmental and social factors. Behav. Ecol. Sociobiol. 6, 265–276.

Jacobs, W. W. (1976): Male-female associations in the domestic Guinea pig. Animal Learning and Behaviour Vol. 4 (IA), 77–83.

King, J. A. (1956): Social relations of the domestic Guinea pig living under semi-natural conditions. Ecology 37, 221–228.

Kunkel, P.; Kunkel, I. (1964): Beiträge zur Ethologie des Hausmeerschweinchens. Z. Tierpsychol. 21, 602–641.

Noble, G. K. (1939): The role of dominance in the social life of birds. Auk 56, 263–273.

Pettijohn, T. F. (1979): Attachment and separation distress in the infant guinea pig. Dev. Psychobiol. Develop. 12, 73–81.

Pitelka, F. A. (1959): Numbers, breeding schedule and territoriality in pectoral sandpipers of northern Alaska. Condor 61, 233–264.

Rood, J. P. (1972): Ecological and behavioural comparisons of three genera of Argentine cavies. Anim. Beh. Monogr. 5, 1–83.

Sachser, N.; Hendrichs, H. (1982): A longitudinal study on the social organization and its dynamics in a group of Guinea pigs (*Cavia aperea* f. porcellus). Säugetierk. Mitt. 30, 227–240.

Siegel, S. (1956): Nonparametric statistics. Tokyo: McGraw-Hill.

Wilson, E. O. (1975): Sociobiology. The New Synthesis. Cambridge, Massachusetts: Belknap Press of Harvard University Press.

Wirtz, P. (1981): Territorial defence and territory take-over by satellite males in the Waterbuck *Kobus ellipsiprymnus* (Bovidae). Behav. Ecol. Sociobiol. 8, 161–162.

Anschrift des Verfassers: Norbert Sachser, Lehrstuhl für Verhaltensphysiologie, Fakultät für Biologie, Universität Bielefeld, Postfach 8640, D-4800 Bielefeld 1

Home range size of Blackbuck, *Antilope cervicapra,* at Mudmal

By N. L. N. S. Prasad

Department of Zoology, Osmania University, Hyderabad, India

Abstract

Investigated the home range size of 11 individually identified adult male blackbuck. The study period of the individuals ranged between 6 and 22 months. The home range size varied from 3.25–13.5 km². The mean home range was 7.66 km². The maximum and minimum mean activity radii were 1.95 km and 0.84 km respectively. Certain grids in the home range were more intensively used than others. The activity centre, in most cases, was located within or adjacent to the grid of maximum use. Some grids were used by two or more individuals and the resources in the area were shared between them either simultaneously or at different times. The overlap values based on the weightage of minimum proportion of sightings in the overlapped grids showed substantial variation. The maximum and minimum values of overlap obtained thus were 76.8 % and 6.6 % respectively.

Introduction

The only information available on the home range of blackbuck at present was from the study of Schaller (1967) at Kanha National Park. Details on the home range size of the free living population of blackbuck helps to draw a perspective management plan for future conservation of the species. This is more so at places where blackbuck co-exist with

cultivators as in many villages in the State of Andhra Pradesh and elsewhere in India. The paper deals with the home range size of 11 individually identified males and the association between them. The differences in the home range size of the individuals and their adaptation to the cultivated fields are discussed.

Materials and methods

Study area

The study was carried out in the neighbourhood of Mudmal village located between $16° 22' - 16° 26'$ N and $77° 25' - 77° 29'$ E. The total area of study was approximately 80 km^2. 81 % of the area was occupied by cultivated fields. A few grassy patches were distributed here and there. Other details of the habitat structure were described by PRASAD and RAMANA RAO (1981).

A preliminary survey of the study area was made and all the vantage points were identified with the aid of the Survey of India maps (1 : 33 000). Taking advantage of the prior knowledge of the frequented areas of blackbuck, part of the study area was demarcated as intensive study area. The intensive study area was divided into 500 × 500 m grids (Fig. 1). The grids were arbitrarily marked with the help of boundaries of cultivated fields, prominent rocky elevations, trees, and groves of phoenix.

Initially, there were 50 blackbuck distributed in 5 separate herds in the study area. The total population increased to over 100 animals by the termination of the studies. During the course of field studies, 11 adult males were individually identified. The natural markings such as the length and shape of horns, the number of spirals in the horns and the intensity of black colour on the coat were chosen as criteria for identification. These bucks were numbered as PB I, PB II, PPR I, PPR II, PPR III, DR I, LG I, LG II, LG III, PM I, and LIMI. All the observations were made during day time with the aid of 8 × 40 binoculars. The period of observations on any single day ranged between 1–10 h.
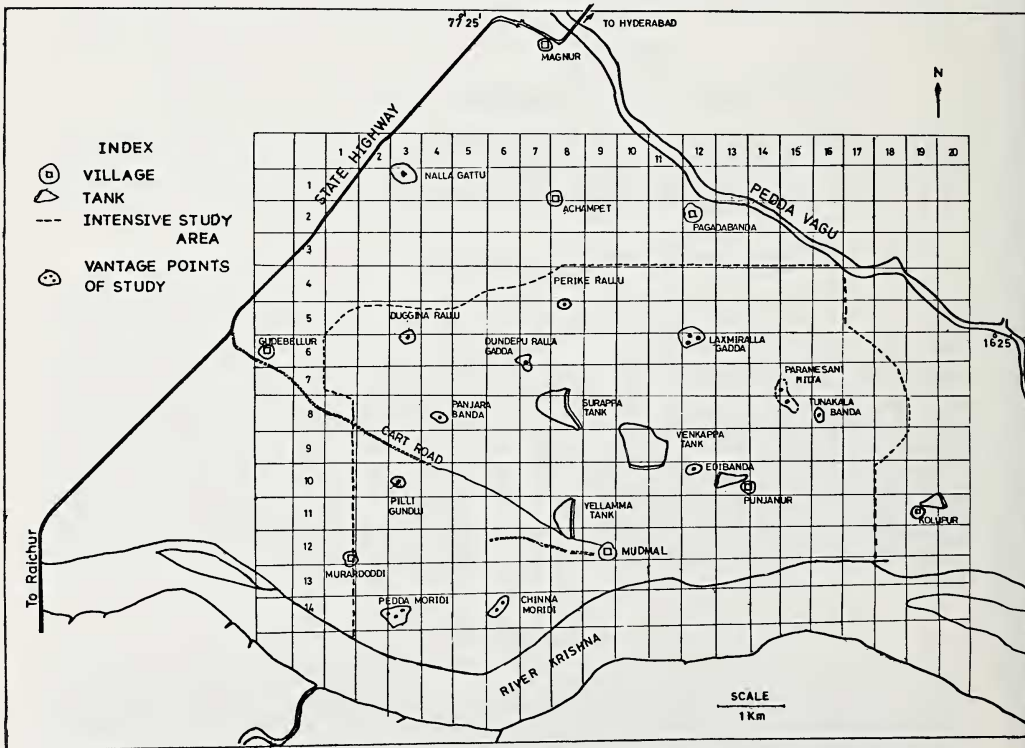

Fig. 1. Study area showing the villages and the vantage points of study

During each observation, the date, time, animal number, grid number in which it was located, and the activity of the individual were recorded. A total of 269 days was spent from April 1978 through February 1980 and over 780 hours of record was obtained on various activity and movement patterns. This was supplemented by the information on the location of the identified individuals gathered by two trained local forest watchman.

Calculations

Home range

A modification of home range fill technique as described by RONGSTAD and TESTER (1969) was followed for determining the home range. Using this method, the grids in which a buck was sighted during the period of observation were summed up and the total area obtained was considered as its home range. The grids with locations that were separated along either axis by one vacant grid, i.e. 0.5 km, were excluded from home range. Although this slightly underestimates the home range, it is useful for finding the use-intensity of the area (RONGSTAD and TESTER 1969).

Activity radius

Another way of describing home range is in terms of the distance from the centre of activity (HAYNE 1949; DICE and CLARK 1953:2). The centre of activity $(\overline{X}, \overline{Y})$ was calculated as follows:

$$\overline{X} = \sum_{i=1}^{n} x_i/n \quad ; \quad \overline{Y} = \sum_{i=1}^{n} y_i/n \qquad \dots . (1)$$

where x and y are coordinates of the centre of each grid and n is the number of grids in the home range.

The mean activity radius weighted by the number of sightings in each grid was calculated by using the following formula:

$$\frac{\Sigma \, (S_i \, \sqrt{[(x_i - \overline{X})^2 + (y_i - \overline{Y})^2]})}{\Sigma \, S_i}$$

where S_i is the number of sightings in each grid.

Degree of aggregation

The geometric centre of activity of all the centres of activity of bucks were obtained by using (1) and the unit distance from the geometric centre to the activity centres of all individuals was derived by:

$$D_u = u \, \sqrt{(\overline{X}_1 - \overline{X}_2)^2 + (\overline{Y}_1 - \overline{Y}_2)^2}$$

where u equals to the number of units. On the basis of the variance and mean of the distances obtained thus, the variance mean (V/m) ratio was calculated to use as an index to measure the degree of aggregation (PIELOU 1969).

Home range overlap

The home range overlap between individuals was calculated following the method suggested by HURLBERT (1978) for the measurement of niche overlap. Thus,

$$\text{Home range overlap ij} = \Sigma_{min} \, (u_i^x \, , u_j^x)$$

where x = all grids overlapped

$$u_i^x = \text{proportion of sightings of individual i in grid x}$$
$$u_j^x = \text{proportion of sightings of individual j in grid x}$$

Out of the two individuals whose home ranges overlapped, the minimum proportion of sightings in the overlapped grids was considered as the value of overlap. Such minimum overlap values of the overlapped grids were summed up to get the total value of overlap. The mean overlap value per grid was used to calculate the association index for drawing a dendrogram, using the method of CODY (1974).

Results

The home range size of the 11 bucks differed greatly (Table 1). Buck DR I, which was observed for a period of 8 months (47 resightings) showed a range size of 3.25 km². Buck PB I, which was followed for a period of 18 months (265 resightings) showed a range size of 13.5 km². Bucks PB II, and LIMI, which were observed for 14 and 22 months respectively (336 and 349 resightings respectively) had a home range size of 13.0 km² each. The mean home range size of all bucks was 7.66 km² (SD 3.89). The maximum activity radius ranged between 1.45 km (PPR III) and 4.21 km (PB II) while the mean activity radius ranged between 0.68 km (DR I) and 1.63 km (LG III).

Table 1

Home range and activity radius of identified bucks

Bucks	Months observed	No. of resight- ings	No. of grids occupied	Area of Home range km²	Activity radius Mean km	Max km
PB I	18	265	54	13.50	1.28	3.19
PB II	14	336	52	13.00	1.07	4.21
PPR I	6	42	19	4.75	0.94	1.95
PPR II	14	106	26	6.50	0.92	2.39
PPR III	7	36	14	3.50	0.87	1.45
DR I	8	47	13	3.25	0.68	2.26
LIMI	22	349	52	13.00	1.15	2.43
PM I	14	87	25	6.25	0.88	2.38
LG I	18	106	28	7.00	0.94	2.30
LG II	17	41	18	4.50	1.04	2.11
LG III	12	92	37	9.25	1.63	2.89

Mean home range = 7.66 km² (SD. 3.89)

The percentage proportion of sightings in various grids in the home range of some of the bucks is shown in Fig. 2. In the case of bucks PPR II and LG I, the centre of activity was located within the grid that contained the maximum proportion of sightings. In the rest of the bucks, the centre of activity was located 0.2 km (PB II) to 1.3 km (LG III) away from the grid that had the maximum proportion of sightings. For LG II, however, the centre of activity was located outside the home range boundary.

The higher proportion of sightings in certain grids in the home range reveals the animal's utilization of that area more intensively either for food or for cover or for other purposes such as maintenance of territory. The grids that have more than the average proportion of sightings were considered to approximate the area of intensive use. Thus, bucks PB I and PB II used only one fifth of their home range, i.e. 2.7 km² and 2.6 km² respectively. Within this area they showed 73 % and 60 % of total sightings respectively. The rest of the bucks showed 55–83 % sightings in less than one third to one half of the respective home range size.

The activity centres of the individual bucks with the geometric centre are shown in Fig. 3. One way of determining the spatial relations of animals is the Variance, mean ratio (V/m) of the distances between the points of animal distribution (ANDREWARTHA 1961; PIELOU 1969). The V/m of the distances from the geometric centre to the centres of activity of all the bucks was 0.27. This shows that the bucks were aggregated.
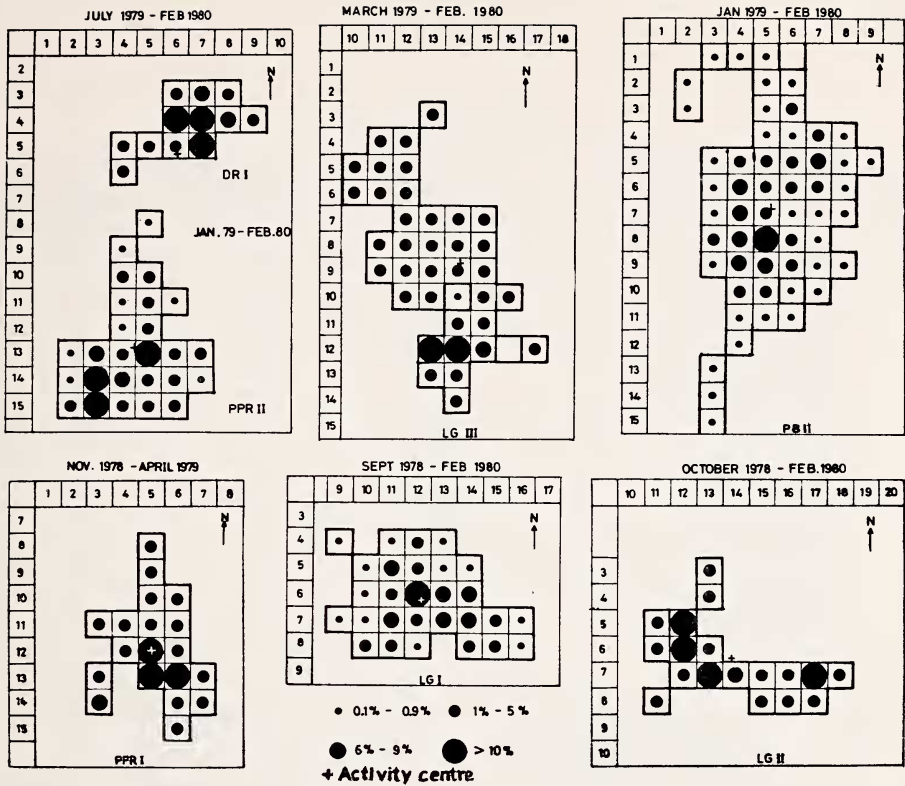
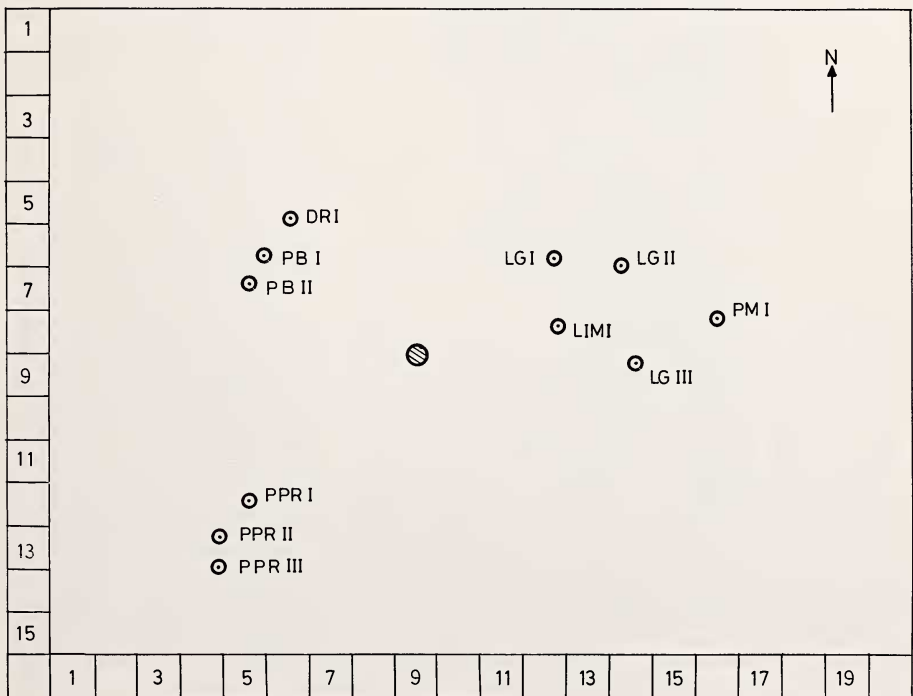Fig. 2. % proportion of sightings in various grids in the home range

Fig. 3. Distribution of activity centres of 11 individual males in space in the study area. ⦰ indicates geometric centre of the activity centres of all individuals

Table 2

The values of home range overlap

| Bucks involved	% proportion of overlap	% mean overlap per grid	Total grids overlapped
PB I and PB II	76.82	1.92	40
PB I and PPR I	7.02	1.17	6
PB I and PPR II	6.59	1.09	7
PB II and PPR I	9.52	1.06	9
PB II and PPR II	7.48	0.75	10
PB II and DR I	20.06	2.23	9
PPR I and PPR II	47.47	3.39	14
PPR II and PPR III	35.99	3.99	9
LIMI and LG I	59.01	2.18	27
LIMI and LG II	45.85	3.06	15
LIMI and LG III	40.79	1.57	26
LIMI and PM I	13.48	1.04	13
LG I and LG II	44.03	3.14	14
LG I and LG III	30.50	1.91	16
LG I and PM I	17.89	1.99	9
LG II and LG III	23.90	2.17	11
LG III and PM I	31.27	3.47	9
LG III and PM I	12.14	1.52	8
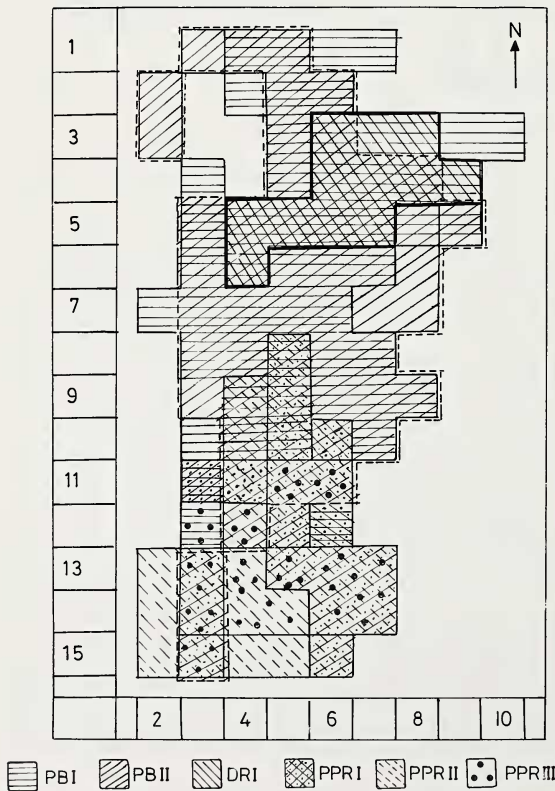
Fig. 4. Home range overlap between bucks

Home range overlap

The home range overlap values between different bucks is shown in Table 2. The overlap was highest between PB I and PB II (76.8 %) where 40 grids were commonly used (Fig. 4). This was followed by the overlap between LIMI and LG I (59 %) where 27 grids were used in common. The rest of the values of overlap between others varied from 6.59 % (PB I and PPR II) to 47.47 % (PPR I and PPR II).

Fig. 5 shows the association between the 11 bucks. The bucks PPR II, PPR III and PPR I were more closely associated in that order. Similarly, the bucks DR I, PB II, and PB I were in a cluster. These two small clusters, however, overlapped forming a single cluster. In the second cluster, the association between LG II and PM I was maximum. This was followed by LG I, LIMI, and LG III.

Discussion

SCHALLER (1967) mentioned that the blackbuck herd at Kanha National Park had a home range of over 2 sq.miles (5.18 km²). This is comparable to the average home range of the present study, i.e. 7.66 km².

The home range of the 11 bucks differed considerably. This is mainly because of the
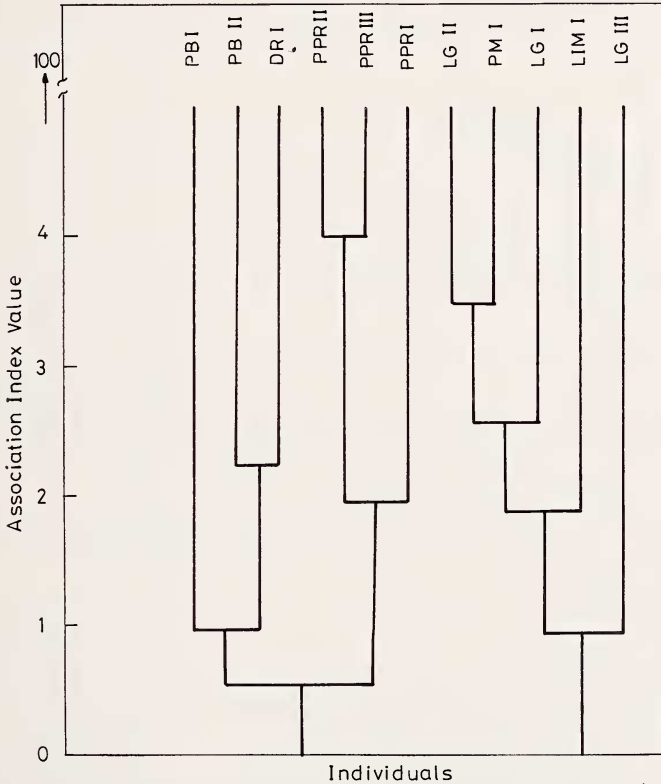

Fig. 5. Dendrogram showing association between bucks

differences in the observation period. To determine the home range size of an individual, one needs to locate all the extreme points covered by it. A lapse in the observation period may miss some of the locations. By plotting the monthwise cumulative home range size (Fig. 6), it is possible to infer that observations spanned over a period of one year is sufficient to determine fairly accurate home range. The home range size of PPR I, PPR III, and DR I are probably underestimated since the period of observation was less than a year. With the exception of bucks PB I and PB II, the rest of the bucks did not show any significant addition to the 12 month home range size. Differences in the home range size are mainly due to interaction between blackbuck and the cultivators. Infact, in the case of bucks PB I and PB II, the increase in the home range after 12 months was because they were driven away from their area by the cultivators with the help of the country dogs. The bucks, however, returned to the same area after a few days. This shows that it is difficult to drive blackbuck away from their home site permanently.

The concept of home range in terms of the centre of activity recognizes greater use per unit area near the centre of an animal's home range and progressively less use with increasing distance from the centre 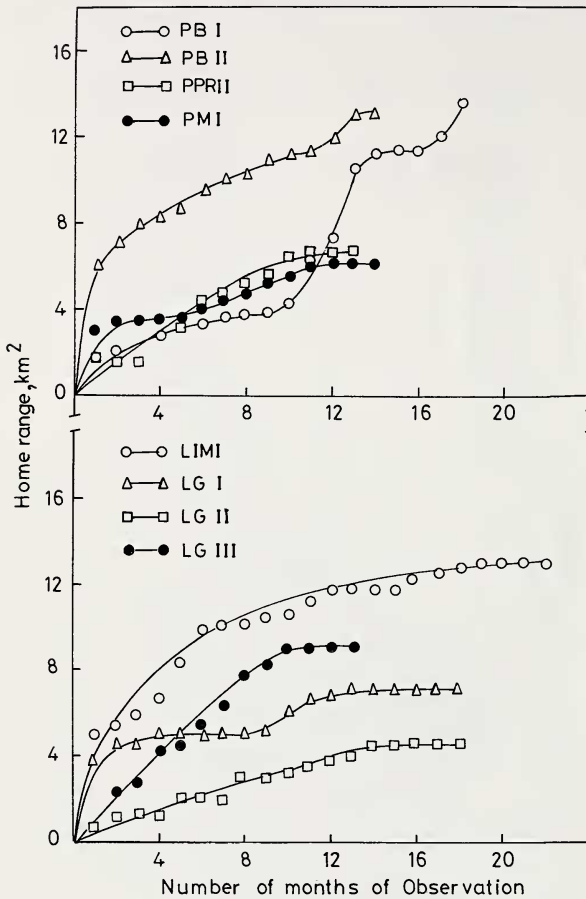(ROBINETTE 1966). In majority of the bucks, the location of the centre of activity within or near the grids with maximum sightings agrees with such a concept although the home range shape was not circular. The location of activity centre away from the area of maximum use in the case of LG III and slightly outside the home range boundary in the case of LG II is difficult to predict.

Fig. 6. Home range of 8 bucks plotted against the number of months of observation

The bucks that have larger home ranges have more number of grids less intensively used while the bucks with smaller home range have more number of grids with greater use-intensity. Bucks PB I, PB II, PPR I, LG III, LIMI, and PM I were highly selective in choosing their territories. These territories, mostly, were located at a slightly elevated area and were surrounded by cultivated fields. These were the areas which formed the foci of activity for these bucks since the females were attracted to these areas due to the richness of the resources.

The maximum overlap between bucks PB I and PB II indicates that bucks of adjacent area interact more frequently. The observations also reveal that slighting of these bucks together was common, particularly, when they face pressure from the cultivators. The other times one can see these bucks together was when the sheep and cattle intrude into their area.

Acknowledgements

Zusammenfassung

Über die Größe des Wohngebietes der Hirschziegenantilope, Antilope cervicapra, in Mudmal, Indien

Untersucht wurde die Größe der Wohngebiete von 11 einzeln identifizierten, erwachsenen, männlichen Hirschziegenantilopen. Die Tiere wurden über eine Dauer von 6 bis 22 Monaten beobachtet. Die Größe der Wohngebiete lag zwischen 3,25 und 13,5 km². Die durchschnittlichen Aktivitätsradien betrugen maximal 1,95 und minimal 0,84 km. Einige Planquadratsflächen der Wohngebiete wurden intensiver benutzt als andere. Das Aktivitätszentrum lag in den meisten Fällen in der maximal benutzten Fläche oder in deren Nähe. Manche Planquadratsflächen wurden von zwei oder mehr Tieren benutzt und die Nahrung dort entweder gleichzeitig oder zu verschiedenen Zeiten aufgenommen. Die Werte für die Überlappung der Wohngebiete zeigten eine erhebliche Streuung. Sie betrugen maximal 76,8 und minimal 6,6 %.

References

ANDREWARTHA, H. G. (1961): Introduction to the study of animal populations. Chicago: The Univ. of Chicago Press.

CODY, M. L. (1974): Competition and structure of Bird Communities. Princeton: Princeton Univ. Press.

DICE, L. R.; CLARK, P. J. (1953:2): The statistical concept of home range as applied to the recapture radius of the deer mouse *(Peromyscus)*. Contrib. Lab. Vert. Biol. Univ. of Michigan 62, 1–15.

HAYNE, D. W. (1949): Calculation of size of home range. J. Mammlogy, 30, 1–18.

HURLBERT, S. H. (1978): The measurement of niche overlap and some relatives. Ecology 59, 67–77.

PIELOU, E. C. (1969): An Introduction to Mathematical Ecology. New York: Wiley – Interscience, A Division of John Wiley and Sons.

PRASAD, N. L. N. S.; RAMANA RAO, J. V. (1981): Evaluation of habitat structure of blackbuck *(Antilope cervicapra)* in Andrha Pradesh with special reference to Mudmal and its relevance to behaviour. Geobios. (in press).

ROBINETTE, W. L. (1966): Mule deer home range and dispersal in Utah. J. Wildl. Manage. 30, 335–348.

RONGSTAD, O. J.; TESTER, J. R. (1969): Movement patterns and habitat use of white-tailed deer in Minnesota. J. Wildl. Manage. 33, 366–379.

SCHALLER, G. B. (1967): The Deer and the Tiger. Chicago: The Univ. of Chicago Press.

Author's address: Dr. N. L. N. S. PRASAD, Zoological Survey of India, 36/802, Karakkamuri Cross Road, Cochin–682 011, India

WISSENSCHAFTLICHE KURZMITTEILUNGEN

Cas d'albinisme chez deux Insectivores Soricidae: *Suncus etruscus* (Savi, 1822) et *Neomys fodiens* (Pennant, 1771)

Par R. FONS, JOSETTE CATALAN et FRANÇOISE POITEVIN

La Pachyure étrusque, *Suncus etruscus* (Savi, 1822)

Aucun cas de coloration aberrante (mélanisme, albinisme) n'était antérieurement connu chez cette espèce.

En juin 1980, un *S. etruscus* présentant une importante coloration blanche a été capturé (fig. 1 A et B). La zone dorsale, la moins marquée, et la face supérieure de la queue, portent